1 434 226

PATENT SPECIFICATION

(11) 1 434 226

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(19) THE PATENT OFFICE LONDON

(54) IMPROVEMENTS IN OR RELATING TO PUMPS

(71) I, SAMUEL ALFRED ROBERTS, a British Subject of Courtways, Holwood Park Avenue, Keston Park, Farnborough, Kent, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to axial flow pumps for pumping liquids and particularly relates to such pumps for use as circulating pumps for small bore central heating systems.

Circulating pumps with high pressure head and low flow-rate characteristics for central heating systems are usually driven by fractional horse-power electric motors and conventionally are of the centrifugal radial flow type. In one such pump, for example, a centrifugal radial flow pump impeller carries the rotor of a disc type induction motor and the stator of the motor is sealed from the liquid flow by a diaphragm seal. One of the required characteristics of a central heating pump is that it be small and compact and for this reason axial flow pumps have generally not been used for this purpose because a conventional fractional horse-power motor mounted axially behind the pump impeller in such a way that it did not impede the liquid flow from the impeller would necessitate a pumping chamber of comparatively large diameter. This problem can be overcome by mounting the motor outside the main pumping chamber but such a solution adds to the complexity of the pump.

It has been found, and this forms the basis of the invention, that by using low-voltage multiphase supply with a frequency greater than 50 Hertz for the electric motor it is possible to produce a simple and relatively inexpensive pump suitable electric motor is mounted axially behind the pump impeller in the pumping chamber.

According to the invention a pump for pumping liquids comprises a tubular pump housing, a cylindrical casing disposed concentrically within the pump housing and forming an annular liquid flow passage between its outer surface and the internal surface of the pump housing, an electric induction motor housed co-axially within the cylindrical casing and adapted to run on low voltage, multi-phase, alternating current electricity supply of a frequency greater than 50 Hertz, and an axial flow impeller mounted on an output shaft of the motor.

By "low voltage" is meant a voltage no more than 25 volts, such a voltage being suitable for a completely immersed motor stator, i.e. a motor in which the pumped liquid completely fills the interior thereof. "Multi-phase" means at least two, and preferably three, phases. As previously indicated the electric motor should be run off an electricity supply with a frequency greater than 50 Hertz and preferably the frequency of the supply will be in the range of 75 to 400 Hertz.

According to a further feature of the invention guide vanes are disposed in the annular flow passage and are adapted to hold the motor co-axially within the pump housing. The pump housing may be a simple tubular member or alternatively may consist of a tubular outer member and a tubular sleeve resiliently mounted co-axially within the outer member. The resilient mounting of the tubular sleeve, for example by a sleeve of resilient material interposed between the inner sleeve and the outer member, isolates the motor and impeller assembly from the outer member

PATENTS ACT 1949

SPECIFICATION NO 1434226

The following amendments were allowed under Section 29 on 29 September 1976

Page 1, line 50, page 4, lines 6 and 76, *after* liquids *insert* in a central heating system

THE PATENT OFFICE
22 October 1976

Bas 31190/5

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This invention relates to axial flow pumps for pumping liquids and particularly relates to such pumps for use as circulating pumps for small bore central heating systems.

Circulating pumps with high pressure head and low flow-rate characteristics for central heating systems are usually driven by fractional horse-power electric motors and conventionally are of the centrifugal radial flow type. In one such pump, for example, a centrifugal radial flow pump impeller carries the rotor of a disc type induction motor and the stator of the motor is sealed from the liquid flow by a diaphragm seal. One of the required characteristics of a central heating pump is that it be small and compact and for this reason axial flow pumps have generally not been used for this purpose because a conventional fractional horse-power motor mounted axially behind the pump impeller in such a way that it did not impede the liquid flow from the impeller would necessitate a pumping chamber of comparatively large diameter. This problem can be overcome by mounting the motor outside the main pumping chamber but such a solution adds to the complexity of the pump.

It has been found, and this forms the basis of the invention, that by using low-voltage multiphase supply with a frequency greater than 50 Hertz for the electric motor it is possible to produce a simple and relatively inexpensive pump suitable for use as a circulating pump for small bore central heating systems in which the electric motor is mounted axially behind the pump impeller in the pumping chamber.

According to the invention a pump for pumping liquids comprises a tubular pump housing, a cylindrical casing disposed concentrically within the pump housing and forming an annular liquid flow passage between its outer surface and the internal surface of the pump housing, an electric induction motor housed co-axially within the cylindrical casing and adapted to run on low voltage, multi-phase, alternating current electricity supply of a frequency greater than 50 Hertz, and an axial flow impeller mounted on an output shaft of the motor.

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According to a further feature of the invention guide vanes are disposed in the annular flow passage and are adapted to hold the motor co-axially within the pump housing. The pump housing may be a simple tubular member or alternatively may consist of a tubular outer member and a tubular sleeve resiliently mounted co-axially within the outer member. The resilient mounting of the tubular sleeve, for example by a sleeve of resilient material interposed between the inner sleeve and the outer member, isolates the motor and impeller assembly from the outer member and thereby reduces the transmission of vibrations from the assembly to the outer

member and to the pipework secured thereto.

The guide vanes disposed in the annular flow passage between the outer surface of the motor casing and the internal surface of the pump housing are preferably formed on the external surface of the motor casing and abut the internal surface of the pump housing. The motor will normally be disposed downstream of the impeller, that is on the delivery side thereof and the guide vanes on the external surface of the motor casing will be so inclined that they act to straighten the liquid flow from the impeller, that is they eliminate or reduce swirl. It is preferred that the guide vanes be disposed in two axially spaced stages.

The electrical supply to the motor may be provided by an electric circuit which comprises a transformer and rectification circuit which converts the mains input, for example 250 volt 50 Hertz domestic supply, to low voltage, direct current and an inverter circuit which converts the low voltage direct current to low voltage, multiphase, alternating current supply with a frequency greater than 50 Hertz for the electric motor, for example 10 volt, three phase and 140 Hertz. The inverter will be driven by a multi-phase oscillator circuit which is preferably provided with an overload cut-out circuit which may be responsive to load dependent temperature rises in critical components of the power circuit such as the secondary winding of the transformer. Variation in the supply to the electric motor may be achieved by varying the voltage, (suitable tappings being provided in the secondary winding of the transformer for this purpose) and/or by variation in the frequency as determined by the oscillator.

Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a cross-section through a pump which is a first embodiment of the invention,

Figure 2 is a partial cross-section through the pump shown in Figure 1 in which the impeller and motor assembly are not shown in section,

Figure 3 is a cross-section through a pump which is a second embodiment of the invention, and

Figure 4 is a schematic illustration of a power supply circuit for a pump according to the invention.

Referring first to Figures 1 and 2, the pump shown therein comprises a tubular housing 1 in which an electric induction motor 2 is co-axially mounted. The motor 2 comprises a squirrel cage rotor 3 mounted on an output shaft 4 and a laminated iron stator 5 which carries a field winding 6. The motor 2 has a casing which consists of two cup-shaped members 7 and 8 of plastics material which are sealed together at their abutting open ends by heat welding or by adhesive. After assembly of the laminated iron stator 5 and the field winding 6 in the casing, the remaining peripheral cavities are preferably filled with a curable filler such as epoxy resin to reduce the effect of small movement of the laminations or the windings. The end walls of the cup-shaped members 7 and 8 have axial apertures 9 and 10, respectively, therein in which carbon bearings 11 and 12 are located, which bearings rotatably mount the shaft 4 in the casing. In the absence of seals, pumped liquid will completely impregnate the interior of the motor 2.

An axial flow impeller 15 is mounted on the end of the shaft 4. The impeller 15 has a hub 16, which is substantially the same diameter as the outside diameter of the casing of the motor 2, on which are formed a multiplicity of hydrofoil-shaped blades 17, which blades 17 will typically have an angle of 9° 5′ at the tip and 10° 38′ at the root, each angle being measured between a plane normal to the axis of the impeller 15 and the datum chord of the hydrofoil section. (It should be understood that impeller blades of the aforesaid configuration are not essential for the employment of the invention and other suitable configurations may be used). A plastics liner 18 is located in a recess in the internal wall of the tubular housing 1 around the periphery of the impeller 15 and the function of this liner 1 is to provide a non-corrosive surface adjacent to the impeller blades 17.

The electric motor 2 is disposed downstream of the impeller 15 and forms an annular passage 19 between the external surface of the casing of the motor and the internal surface of the housing 1 through which the liquid flows from the impeller 15. The outer surface of the casing of the motor is provided with radially extending guide vanes and a first stage of hydrofoil guide vanes 20 is formed on the cup-shaped casing member 7 and a second stage of hydrofoil guide vanes 21 is formed on the cup-shaped casing member 8 (as shown most clearly in Figure 2). The two guide vane stages will normally be of different configuration and I prefer to use a first stage of five guide vanes which are angled at 47° 25′ at the tip and 45° 41′ at the root (said angles being measured between a plane normal to the axis of the motor 2 and the datum chord of the hydrofoil section) and a second stage of

four guide vanes angled at 80° at the tip and 76° 48′ at the root. The guide vanes 20 and 21 serve first to eliminate the swirl of liquid flowing through the annular passage 19 and secondly, by abutting the internal surface of the housing, to support the motor 2 co-axially within the housing 1. The guide vanes 20 and 21 may be an interference fit in the housing 1 and thereby serve to prevent axial movement of electric motor within the housing 1 or alternatively may be a loose fit, other means being provided to axially secure the motor.

The electric supply wires 22 for the electric motor 2 are housed in a member 23 which fits in, and is sealed to, aligned slots in the housing 1 and the casing member 8 and which bridges the annular passage 19. The bridging member 23 will usually be formed from a synthetic plastics material and conveniently is formed from a heat shrinkable material which facilitates the securement of the supply wires 22 therein.

The housing 1 has end connections 24 secured thereto whereby the pump may be connected to the pipework of a liquid circuit. The end connections locate on spigots 25 at the ends of the housing 1 and accommodate 'O'-ring seals 26 which maintain a liquid-tight seal between the end connections 24 and the housing 1.

The second embodiment of the invention shown in Figure 3 is very similar to the first embodiment and differs chiefly in that the simple tubular housing 1 of the first embodiment is replaced by a housing 27 which consists of an outer tubular member 28, an inner tubular sleeve 29 and a resilient sleeve 30 interposed between the outer member 28 and the inner sleeve 29. The resilient sleeve 30 is a sleeve of resilient expanded material, for example expanded rubber material such as closed cell ethylene-propylene diene monomer, and is bonded to the inner sleeve 29 and the outer member 28 by a suitable adhesive. Whilst this embodiment is shown with a single relatively short resilient sleeve which is centrally disposed, it should be understood that a longer sleeve, or a plurality of axially spaced sleeves may be used provided that the required flexibility is obtained in all modes of movement. An electric motor and impeller assembly 31 is mounted co-axially within the inner sleeve of the housing 27 by guide vanes formed on the external surface of the motor casing in an exactly similar manner to the mounting of the motor and impeller assembly in the tubular housing 1 of the first embodiment.

The resilient sleeve 30 serves to isolate the motor and impeller assembly 31 from the outer member 28 and thus prevents or reduces the transmission of vibration from the motor and impeller assembly to the outer member 28 and to the pipework connected to the end connections 32 secured to the outer member 28. Unlike the first embodiment of the invention the housing 27 locates on spigots 34 on the end connections 32 and is secured thereto by an adhesive which obviates the need for 'O'-ring seals.

The electric supply wires 33 pass through a water-tight grommet 36 in the outer member 28 and span unsupported the annular passage 35 between the inner sleeve 29 and the motor and impeller assembly 31. The grommet 36 is axially spaced from the point at which the wires 33 span the annular passage 35 to leave a relatively long length of wire therebetween which reduces the transmission of vibrations by the wires to the outer member 28. Whilst the wires 33 are shown unsupported in spanning the annular passage 35 they could be supported by a bridging member as in the first embodiment of the invention or alternatively could be accommodated in one of the guide vanes 21.

The electric motor is identical with the electric motor shown in Figure 1.

Many component parts of the pump according to the invention may be made from synthetic plastics material provided that the material used has a high stability and high strength at the working temperature of the pump, which, in the case of a central heating pump, will be about 80°C. Purely by way of example, the pump impeller may be made from polyphenylene oxide with a 30% glass filling and the motor casing and the inner sleeve 29 of the second embodiment may be made from polyphenylene oxide with a 20% glass filling.

The power supply to the pump, illustrated schematically in Figure 4, comprises a transformer, rectifier and smoother circuit 38 which transforms the alternating current into low voltage direct current, a multiphase oscillator circuit 39, and an inverter circuit 40 driven by the oscillator circuit 39 which converts the low voltage direct current output from the transformer and rectifier circuit 38 into low voltage, multi-phase, alternating current supply for the pump motor 41. An overload protection circuit 42 is provided which is responsive to load dependent temperature rises in critical components of the circuit 38, such as the secondary winding of the transformer.

A pump according to the present invention can be made to be of compact size and, purely by way of example, a typical pump for use as a circulating pump of a domestic central heating system can be made with dimensions as follows:—

Outside diameter of electric motor — 1.68 inches.

Outside diameter of impeller — 2.00 inches.

WHAT I CLAIM IS:—

1. A pump for pumping liquids comprising a tubular pump housing, a cylindrical casing disposed concentrically within the pump housing and forming an annular liquid flow passage between its outer surface and the internal surface of the pump housing, an electric induction motor housed co-axially within the cylindrical casing and adapted to run on low voltage, multi-phase, alternating current electricity supply of a frequency greater than 50 Hertz and an axial flow impeller mounted on an output shaft of the motor.

2. A pump according to Claim 1 wherein guide vanes are disposed in the annular flow passage and are adapted to hold the electric motor co-axially within the housing.

3. A pump according to Claim 2 wherein the guide vanes are disposed in two axially spaced stages.

4. A pump according to Claim 2 or Claim 3 wherein the guide vanes are formed on the external surface of the casing.

5. A pump according to Claim 4 wherein the casing is formed by two cup-shaped members which have their open ends secured together and the peripheral surface of each of the cup-shaped members has a plurality of guide vanes formed thereon.

6. A pump according to any one of the preceding claims wherein a sleeve of plastics material is located in a recess in the internal surface of the tubular housing lying in juxtaposition to the periphery of the impeller.

7. A pump according to any one of the preceding claims wherein the tubular housing comprises an outer tubular member and an inner tubular sleeve resiliently located co-axially within the outer member.

8. A pump according to Claim 7 wherein the inner sleeve is resiliently mounted by a sleeve of resilient material interposed between the inner sleeve and the outer member.

9. A pump according to Claim 8 wherein the resilient sleeve is a sleeve of resilient expanded rubber material.

10. A pump according to Claim 9 wherein the resilient sleeve is a sleeve of resilient closed cell ethylene-propylene diene monomer.

11. A pump according to any one of Claims 7 to 10 wherein electricity supply wires for the electric motor pass through a water-tight grommet in the outer member which is axially spaced from the point at which the wires pass through the inner sleeve.

12. A pump according to any one of the preceding claims wherein an end connection is secured to each end of the tubular housing and such connections form an axial inlet to and an axial outlet from the housing.

13. A pump according to any one of the preceding claims wherein the electric motor is a multi-phase squirrel cage motor.

14. A pump for pumping liquids constructed and adapted to operate substantially as hereinbefore described with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.

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Chartered Patent Agent.
Agent for Applicant.

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1434226 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

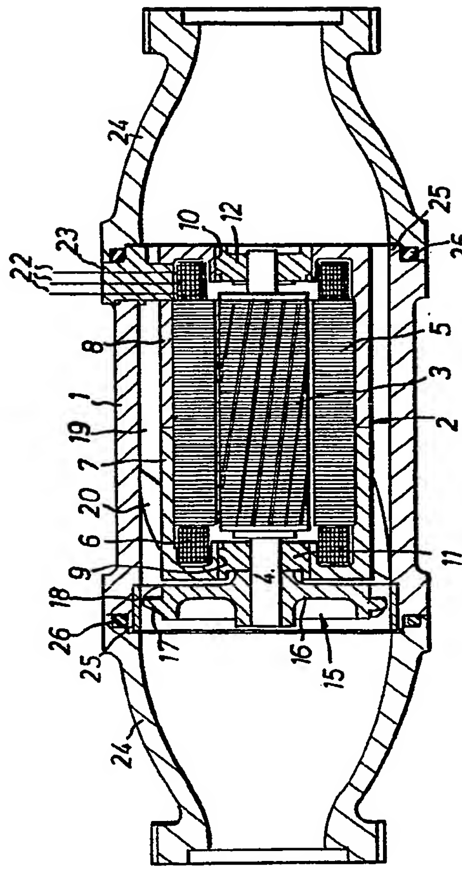

FIG.1

1434226 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

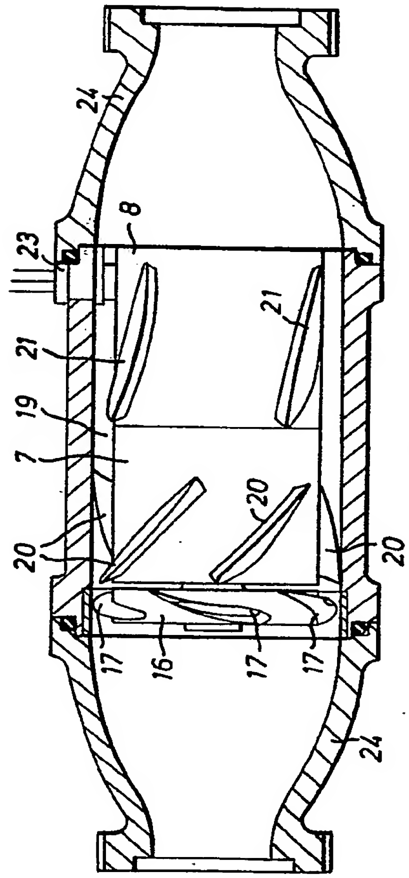

FIG. 2

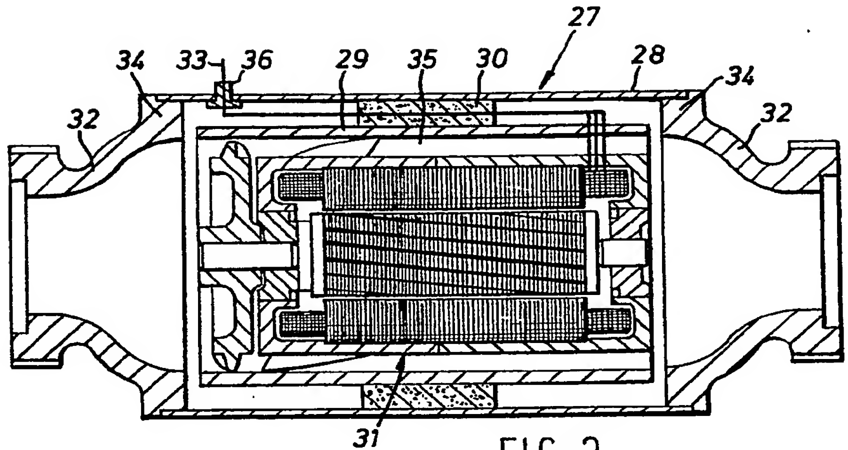

FIG. 3

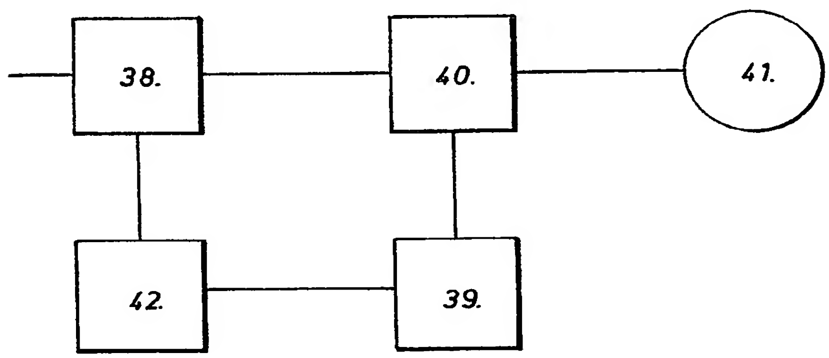

FIG. 4